

**EFFECT OF POSTHARVEST
HOT-WATER TREATMENTS
ON SPOILAGE OF CRANBERRIES
IN STORAGE**

Marketing Research Report No. 928

**Agricultural Research
UNITED STATES DEPARTMENT**

CONTENTS

| | Page |
|----------------------------------|------|
| Summary | 1 |
| Introduction | 1 |
| Test I: | |
| Materials and methods | 1 |
| Results: | |
| 70° storage | 2 |
| 38° storage | 2 |
| Pathogen survival | 2 |
| Test II: | |
| Materials and methods | 2 |
| Results | 3 |
| Test III: | |
| Materials and methods | 4 |
| Results | 5 |
| Discussion and conclusions | 6 |
| Literature cited | 8 |

EFFECT OF POSTHARVEST HOT-WATER TREATMENTS ON SPOILAGE OF CRANBERRIES IN STORAGE

By R. E. ANDERSON, *Research Horticulturist*, and WILSON L. SMITH, JR., *Research Plant Pathologist*,
*Market Quality Research Division, Agricultural Research Service*¹

SUMMARY

Hot-water treatments to reduce the development of spoilage of cranberries during or after storage were tested for 3 years. Treating berries before storage in 110°, 115°, 120°, or 125° F. water for 20, 10, 5, and 2½ minutes, respectively, reduced the number of pathogens that survived, but did not always reduce the total spoilage of the berries. Generally the hot-water treatments reduced the development of spoilage better in early-harvested than in late-harvested berries. Hot-water treatments apparently increased the amount of physiological breakdown in late-harvested berries. The early-harvested berries developed less spoilage than the late-harvested ones.

INTRODUCTION

Losses of cranberries in storage are due largely to physiological breakdown and decay. Storage at 32° F. delays the development of decay, but losses due to low-temperature breakdown increase. This type of breakdown can be reduced by storage at 36° to 40° (11)² or by intermittent warming (6). However, at 36° to 40° development of decay is not delayed as much as it would be at 32°. Much of the decay that develops in storage results from infection that occurred in the field during and immediately after flowering, when the fungi causing fruit rots enter the flowers and developing fruit (3). Field applications of fungicides have reduced the amount of decay but have not eliminated it,

either in the field or in storage (2, 4, 8, 9, 12). Recently hot-water treatments have proved effective in preventing development of decay in fruits and vegetables already infected (1, 5, 7, 10). Hot-water treatments, therefore, were tested to reduce development of decay in cranberries during storage.

In preliminary tests berries were severely damaged by dipping them in water at 140° F. for 1 minute, at 131° for 2 minutes, or at 125° for 5 minutes. Dipping in water at 131° for 1 minute, 125° for 2½ minutes, 120° for 7 minutes, 115° for 10 minutes, or 110° for 20 minutes did not damage the fruit. Isolations from decayed berries showed that the hot-water treatments reduced the number of viable pathogens.

TEST I

Materials and Methods

Late Howes cranberries were obtained from the University of Massachusetts Cranberry Station at East Wareham, Mass. shortly after harvest in mid-October for a storage test at Beltsville, Md. The berries were handsorted to remove all that were visibly spoiled or damaged. The cleaned berries were then inoculated by dipping them in a slurry of ground decayed berries and water for 1 minute. After removal from this slurry, the berries were allowed to dry.

Sample size was 100 berries per treatment. Treatments included a dry control and the following water-immersion dips: 20 and 10 minutes at 70° F.; 20, 10, 5, and 2½ minutes at 110°; 10, 5, and 2½ minutes at 115°; 5 and 2½ minutes at 120°; and 2½ and 1¼ minutes at 125°. After treatment, the berries were air-dried and placed in new 3-lb. kraft paper bags, which were sealed and placed in storage. Five duplicate samples of each treatment were stored at 38°, and four duplicate samples were stored at 70°. Those stored at 70°

¹ The authors acknowledge the cooperation of the following people and organizations in making these tests possible: Chester Cross and E. I. Demoranville of the University of Massachusetts, Cranberry Station, East Wareham, Mass.; Ocean Spray Cranberries Inc., Onset, Mass.; and H. C. Vaught, former Laboratory Technician, U.S. Department of Agriculture, Beltsville, Md.

² Italicized numbers in parentheses refer to Literature Cited, p. 8.

were inspected after 1, 2, 4, and 6 weeks, and those at 38° after 2, 3, 4, 5, and 6 months. Duplicate samples of 100 berries were examined at each inspection. After the removal inspection of the 38° stored samples, the remaining good berries were held 7 days at 70° and reinspected. Spoilage after the 7 days was included with the spoilage that was present at removal.

Spoilage, as classified in these tests (except where noted), included berries that were considered to be unmarketable due either to decay or to physiological breakdown.

After each removal inspection of the 38° F. lots, 10 spoiled berries were selected from representative treatments. Isolations were made from each spoiled berry on potato dextrose agar. These isolates were incubated at 75° and observed to determine the percent survival of cranberry pathogens.

Results

70° storage

Spoilage of cranberries at 70° F. usually increased with the length of storage (table 1). Those dipped in 110° water for 20 minutes and in 120° for 5 or 2½ minutes and in 125° water for 2½ minutes developed significantly less

spoilage than the wet controls, which had been dipped in 70° water. All of the berries given the hot-water dips developed less spoilage than the dry controls.

38° storage

Cranberries given the longest exposure each of the hot-water treatments had significantly less spoilage than the wet control (table 2). Also all of the hot-water treated berries except the 2½-minute dips in 110° or 115° water had significantly less spoilage than dry control. Within each hot-water treatment decreasing the dipping time resulted in a greater amount of spoiled berries. Despite treatment, spoilage increased with time storage.

Pathogen survival

Growth of fungi isolated from nonheated spoiled berries resembled that of the previously described cranberry pathogens *Godronia*, *Sporonema*, or *Pestalotia* (8). The survival of these pathogens after storage was least in the same hot-water treated lots in which spoilage was least. Within each of the higher temperature dips, the shorter dipping time was ineffective in reducing pathogen survival (table 3).

TABLE 1.—*Spoilage of cranberries in storage at 70° F.*

| Prestorage treatment | | Spoilage after ¹ — | | | | |
|----------------------|----------|-------------------------------|---------|---------|---------|-------------------|
| Water temp. | Dip time | 1 week | 2 weeks | 4 weeks | 6 weeks | Mean ² |
| ° F. | Min. | Pct. | Pct. | Pct. | Pct. | Pct. |
| 70 | 20 | 12 | 17 | 16 | 31 | 19 cde |
| 70 | 10 | 22 | 21 | 17 | 20 | 20 de |
| 110 | 20 | 6 | 7 | 11 | 21 | 11ab |
| 110 | 10 | 10 | 14 | 10 | 15 | 12 bc |
| 110 | 5 | 8 | 11 | 14 | 20 | 13 bcd |
| 110 | 2½ | 3 | 9 | 13 | 22 | 12 bc |
| 115 | 10 | 10 | 12 | 11 | 15 | 12 bc |
| 115 | 5 | 10 | 9 | 19 | 14 | 13 bc |
| 115 | 2½ | 10 | 9 | 17 | 27 | 16 bcd |
| 120 | 5 | 10 | 7 | 7 | 15 | 10ab |
| 120 | 2½ | 7 | 5 | 7 | 14 | 8ab |
| 125 | 2½ | 3 | 2 | 6 | 7 | 5a |
| 125 | 1¼ | 8 | 11 | 13 | 17 | 12 bc |
| Dry control | | 17 | 22 | 22 | 31 | 23 e |
| Mean | | 9.7 | 11.1 | 13.1 | 19.2 | 13.3 |

¹ Individual values represent mean of duplicate samples of 100 berries each.

² Means are of 8 samples. Duncan Multiple Range Test letters are for significance at 1-percent level. Means followed by letter in common do not differ significantly from one another.

TEST II

Materials and Methods

Another test was set up the following season using cranberries harvested in October from three different bogs in Massachusetts. 1 sorted and nonsorted berries were used. The sorting consisted of running the berries through a commercial cranberry separator, followed by passage over a ½-inch-wire-mesh screen. The nonsorted berries were used as brought in from the field, in the chaff. Spoilage for the sorted berries at this time ranged from 4.2 to 4.6 percent, and for the nonsorted berries from 4.4 to 12.5 percent.

Three prestorage treatments were tested: (1) dry control, (2) 115° F. water dip for 10 minutes, and (3) 125° water dip for 2½ minutes. After the dip treatments, the berries (one-pound samples) were air-dried at room temperature and packaged in 1-pound waxed cartons with a transparent film window. Three replicate cartons of each treatment from each storage house were placed in each of three storage houses.

After storage for 4 months at about 38° F., 100 berries from each sample were inspected, and the remainder of the sample placed at 70°. After 7 days at 70°, a second 100-berry sample was inspected for spoilage.

TABLE 2.—*Spoilage of cranberries after storage at 38° F. plus 7 days at 70°*

| Prestorage treatment | | Spoilage after ¹ — | | | | | |
|----------------------|----------|-------------------------------|----------|----------|----------|----------|-------------------|
| Water temp. | Dip time | 2 months | 3 months | 4 months | 5 months | 6 months | Mean ² |
| °F. | Min. | Pct. | Pct. | Pct. | Pct. | Pct. | Pct. |
| 70 | 20 | 20 | 30 | 36 | 54 | 63 | 41 defg |
| 70 | 10 | 29 | 32 | 44 | 55 | 67 | 45 fg |
| 110 | 20 | 18 | 14 | 24 | 28 | 39 | 25ab |
| 110 | 10 | 18 | 23 | 42 | 55 | 58 | 39 def |
| 110 | 5 | 20 | 22 | 33 | 46 | 58 | 36 cdef |
| 110 | 2½ | 23 | 37 | 41 | 48 | 65 | 43 efg |
| 115 | 10 | 12 | 11 | 24 | 26 | 39 | 23a |
| 115 | 5 | 21 | 19 | 30 | 36 | 58 | 33 bcd |
| 115 | 2½ | 21 | 31 | 39 | 50 | 63 | 41 defg |
| 120 | 5 | 12 | 24 | 22 | 31 | 50 | 28abc |
| 120 | 2½ | 12 | 27 | 36 | 40 | 56 | 34 bcde |
| 125 | 2½ | 16 | 21 | 20 | 22 | 39 | 23a |
| 125 | 1¼ | 11 | 20 | 33 | 53 | 47 | 33 bcd |
| Dry control | | 32 | 45 | 47 | 58 | 64 | 49 g |
| Mean | | 19 | 25 | 34 | 43 | 55 | 35 |

¹ Individual values represent mean of duplicate samples of 100 berries each.² Means are of 10 samples. Duncan Multiple Range Test letters are for significance at 1-percent level. Means followed by letter in common do not differ significantly from one another.TABLE 3.—*Survival of pathogens in cranberries stored at 38° F.*

| Prestorage treatment | | Pathogens recovered after storage ¹ | | | | | |
|----------------------|----------|--|----------|----------|----------|----------|-------------------|
| Water temp. | Dip time | 2 months | 3 months | 4 months | 5 months | 6 months | Mean ² |
| °F. | Min. | Pct. | Pct. | Pct. | Pct. | Pct. | Pct. |
| 70 | 20 | 100 | 90 | 70 | 100 | 90 | 90 d |
| 110 | 20 | 40 | 30 | 40 | 20 | 50 | 36a |
| 110 | 10 | 60 | 80 | 80 | 90 | 90 | 80 cd |
| 115 | 10 | 20 | 20 | 60 | 40 | 30 | 34a |
| 115 | 5 | 80 | 90 | 80 | 90 | 90 | 86 d |
| 120 | 5 | 50 | 80 | 30 | 40 | 60 | 52abc |
| 120 | 2½ | 60 | 60 | 100 | 80 | 80 | 76 cd |
| 125 | 2½ | 30 | 20 | 20 | 70 | 90 | 46ab |
| 125 | 1¼ | 50 | 60 | 80 | 80 | 90 | 72 bcd |
| Dry control | | 100 | 90 | 90 | 100 | 90 | 94 d |

¹ Individual values obtained from isolations made from 10 berries per duplicate sample after indicated storage period.² Duncan Multiple Range Test at 1-percent level. Means followed by letter in common are not significantly different from one another.

Results

On removal from storage, both the sorted and nonsorted berries from bog I that were treated with 115° or 125° F. water had significantly less spoilage than the controls (table 4). The hot-water treatments did not reduce the development of spoilage in berries from the other

two bogs. In fact, the hot-water treatments increased spoilage of the nonsorted berries from bog III.

After 7 days at 70° F., sorted berries from bog I treated with 115° or 125° water had less spoilage than the controls (table 5). The heated nonsorted berries had about the same amount of spoilage as the controls. The hot-water treat-

EFFECT OF HOT-WATER TREATMENTS ON SPOILAGE OF CRANBERRIES

TABLE 4.—*Spoilage of cranberries from different bogs after 4 months' storage at 38° F.*

| Prestorage treatment | Spoilage ¹ | | | | |
|-------------------------|-----------------------|--------|---------|----------------|------|
| | Bog I | Bog II | Bog III | Treatment mean | Mean |
| | Pct. | Pct. | Pct. | Pct. | Pct. |
| Sorted berries | | | | | 23a |
| Control | 19 cd | 22 b | 31ab | 24 b | |
| 115° F. water (10 min.) | 13ab | 25 b | 36 bc | 25 b | |
| 125° F. water (2½ min.) | 12a | 23 b | 20a | 19a | |
| Nonsorted berries | | | | | 26 b |
| Control | 22 d | 20ab | 30ab | 24 b | |
| 115° F. water (10 min.) | 16abc | 20ab | 50 d | 29 b | |
| 125° F. water (2½ min.) | 17 bc | 16a | 44 cd | 26 b | |
| Bog mean | 16a | 21 b | 35 c | | |

¹ Each value is the mean of nine 100-berry samples. Compare means within blocks only. Means followed by no letters in common differ from each other at the 5-percent level as determined by the Duncan Multiple Range Test.

ments did not reduce the amount of spoilage that developed in berries from bogs II or III and even increased it in several lots of berries.

The overall means show sorted berries treated in 125° F. water for 2½ minutes had less spoilage when they were removed from storage than those from the other hot-water treatments or the control (table 4—treatment means). This treatment, however, did not reduce spoilage of the nonsorted berries. Seven days after removal from storage, neither of the hot-water treatments effectively reduced spoilage (table 5—treatment means).

Differences in spoilage between sorted and nonsorted berries were small. At removal from storage, sorted berries had significantly less spoilage than did the nonsorted berries (table 4). After 7 days' holding at 70° F. the sorted and nonsorted berries had about the same amount of spoilage (table 5).

Cranberries from the different bogs developed different amounts of spoilage (tables 4 and 5—bog means). Both at removal from storage and after the 7-day holding period, berries from bog I had the least, and those from bog III the greatest, amount of spoilage.

There may be a possible explanation for these different responses of berries from the different

bogs. Cranberries from bog I were harvested 2 weeks earlier than those from bog II, which in turn were harvested 3 days earlier than those from bog III. This might indicate that less decay is likely to occur in early-harvested or less mature berries. It might also indicate that the earlier harvested berries are more tolerant to heat treatments than are later harvested ones. The latter may be more susceptible to injury by hot water.

TEST III

Materials and Methods

The theory that maturity of cranberries may influence the amount of decay and susceptibility to heat damage was investigated the following season. Three harvests of Late Howes cranberries were made from each of three bogs in Massachusetts at approximately 10-day intervals. The first harvest was about 10 days earlier than the commercial harvest date of this variety. At each harvest, berries were sorted on a commercial separator and passed over a ½-inch mesh wire screen to remove chaff, very small berries, and most of the spoiled berries.

All lots were treated at Beltsville, Md. within

TABLE 5.—*Spoilage of cranberries from different bogs after storage at 38° F. for 4 months plus 7 days at 70°*

| Prestorage treatment | Spoilage ¹ | | | | |
|-------------------------|-----------------------|--------|---------|----------------|------|
| | Bog I | Bog II | Bog III | Treatment mean | Mean |
| | Pct. | Pct. | Pct. | Pct. | Pct. |
| Sorted berries | | | | | 33a |
| Control | 27 c | 29ab | 39a | 32a | |
| 115° F. water (10 min.) | 19a | 39 c | 48 b | 35a | |
| 125° F. water (2½ min.) | 20ab | 36 bc | 39a | 32a | |
| Nonsorted berries | | | | | 34a |
| Control | 26abc | 27a | 36a | 30a | |
| 115° F. water (10 min.) | 23abc | 31ab | 58 c | 37a | |
| 125° F. water (2½ min.) | 26abc | 28a | 52 b | 35a | |
| Bog mean | 24a | 32 b | 45 c | | |

¹ Each value is the mean of nine 100-berry samples. Compare means within blocks only. Means followed by no letters in common differ from each other at the 5-percent level as determined by the Duncan Multiple Range Test.

2 weeks of harvest. Initial inspection after harvest showed that spoilage ranged from 0.3 to 4.5 percent in fruit from the three bogs. The greatest spoilage was in the berries harvested last. Treatments before storage were as follows: (1) dry control, (2) 115° F. water dip for 10 minutes, and (3) 125° water dip for 2½ minutes. Three 1-pound samples of each treatment for each harvest and from each bog were stored at 38° for 3 months. On removal from storage, one 100-berry sample from each 1-pound carton was examined for spoilage. The remaining berries were placed at 70°, and three 100-berry samples from each carton were examined for spoilage after 1 week.

Results

On removal from 3 months of storage, the early- and midseason-harvested cranberries treated with 115° or 125° F. water had considerably less spoilage than the controls (table 6). Berries from the late harvest given the 115° water-dip treatment also had less spoilage than the controls, but those given the 125° treatment had almost triple the amount of spoilage in the control.

After 7 days at 70° F. treated berries from

the early harvest had significantly less spoilage than the controls (table 7). There was no significant difference in the amount of spoilage between the control and either of the heat-treated lots from the midseason harvest. Berries receiving the 125° water treatment of the late harvest had significantly more spoilage than either the control or the 115° water-treated fruit. Treatment means showed that berries receiving the 115° water treatment developed less spoilage than did those from the 125° treatment or the control.

In this test an attempt was also made to separate spoilage due to pathological decay or to physiological breakdown. By comparing data in tables 7 and 8, the amount of spoilage due to physiological breakdown becomes apparent. Most of the spoilage of the berries, except those from the late harvest given the 125° F. water-dip treatment, appeared to be caused by decay-producing organisms. In the late harvest more than half the spoilage of the berries treated in 125° water was due to nonpathological breakdown. These berries apparently were severely injured by the hot-water treatment, which caused an increase in physiological breakdown.

In general, the later the cranberries were

EFFECT OF HOT-WATER TREATMENTS ON SPOILAGE OF CRANBERRIES

TABLE 6.—*Spoilage of cranberries of different harvest periods after 3 months' storage at 38° F.*

| Prestorage treatment | Spoilage ¹ | | | Treatment mean |
|----------------------------------|-----------------------|-------------|-------------|----------------|
| | Harvest period | | | |
| | Early | Midseason | Late | |
| | <i>Pct.</i> | <i>Pct.</i> | <i>Pct.</i> | <i>Pct.</i> |
| Control _____ | 17 b | 17 b | 22 c | 19 b |
| 115° F. water (10 min.) _____ | 6a | 8a | 11a | 8a |
| 125° F. water (2½ min.) _____ | 8a | 9a | 60 d | 26 c |
| Harvest mean _____ | 10a | 11a | 31 b | |

¹ Each value is the mean of three 100-berry samples, each from a different bog. Compare means within blocks. Means followed by no letters in common differ from each other at the 5-percent level as determined by the Duncan Multiple Range Test.

TABLE 7.—*Spoilage of cranberries of different harvest periods after 3 months' storage at 38° F. plus 7 days at 70°*

| Prestorage treatment | Spoilage ¹ | | | Treatment mean |
|----------------------------------|-----------------------|-------------|-------------|-------------------|
| | Harvest period | | | |
| | Early | Midseason | Late | |
| | <i>Pct.</i> | <i>Pct.</i> | <i>Pct.</i> | <i>Pct.</i> |
| Control ----- | 21 bc | 22 bc | 29 d | 24 b |
| 115° F. water (10 min.) ----- | 9a | 16ab | 23 cd | 16a |
| 125° F. water (2½ min.) ----- | 11a | 19 bc | 84 e | 38 c |
| Harvest mean ----- | 14a | 19 b | 46 c | |

¹ Each value is the mean of nine 100-berry samples. Compare means within blocks. Means followed by no letters in common differ from each other at the 1-percent level as determined by the Duncan Multiple Range Test.

harvested, the greater the amount of spoilage, regardless of the treatment or the bog from which the berries were obtained. Some difference in spoilage also occurred in the berries from the different bogs (table 9). The bog with most spoilage the previous season (data not shown) had the least spoilage in Test III (table 9).

DISCUSSION AND CONCLUSIONS

On the basis of these tests, the use of brief hot-water treatments before storage of cranberries is not recommended as a method of controlling spoilage. Data show that a large percentage of the organisms causing cranberry decay can be killed by treatment in 110° to

TABLE 8.—*Decay of cranberries of different harvest periods after 3 months' storage at 38° F. plus 7 days at 70°*

| Prestorage treatment | Decay ¹ | | | Treatment mean |
|----------------------------------|--------------------|-------------|-------------|-------------------|
| | Harvest period | | | |
| | Early | Midseason | Late | |
| | <i>Pct.</i> | <i>Pct.</i> | <i>Pct.</i> | <i>Pct.</i> |
| Control ----- | 20 cd | 19 bcd | 22 d | 20 b |
| 115° F. water (10 min.) ----- | 7a | 13ab | 19 bcd | 13a |
| 125° F. water (2½ min.) ----- | 8a | 13ab | 37 e | 19 b |
| Harvest mean ----- | 11a | 15 b | 26 c | |

¹ Each value is the mean of nine 100-berry samples. Compare means within blocks. Means followed by no letters in common differ from each other at the 5-percent level as determined by the Duncan Multiple Range Test.

TABLE 9.—*Spoilage of cranberries of different harvest periods from different bogs after 3 months' storage at 38° F. plus 7 days at 70°*

| Bog | Spoilage ¹ | | | |
|--------------------|-----------------------|-------------|-------------|-------------|
| | Harvest period | | | Bog mean |
| | Early | Midseason | Late | |
| | <i>Pct.</i> | <i>Pct.</i> | <i>Pct.</i> | <i>Pct.</i> |
| I _____ | 16ab | 20ab | 50 d | 28 b |
| II _____ | 16ab | 25 bc | 52 d | 31 c |
| III _____ | 8a | 11ab | 35 c | 18a |
| Harvest mean _____ | 14a | 19 b | 46 c | |

¹ Each value is the mean of nine 100-berry samples. Compare means within blocks. Means followed by no letters in common differ from each other at the 1-percent level as determined by the Duncan Multiple Range Test.

125° F. water, but total spoilage of the berries during storage and a simulated marketing period was not greatly reduced. It would appear, therefore, that more knowledge of the causes of physiological breakdown of cranberries must be obtained before hot-water treatments can be successfully applied. The present study indicates that the harvest date of the fruit is a major factor contributing to

spoilage of cranberries during subsequent storage. With early-harvested berries, treatment in either 115° or 125° water gave satisfactory control of spoilage. For the midseason or late-harvested berries, treatment in 115° water is preferable, as apparently less physiological breakdown occurred on berries treated at this temperature than on those treated at 125°.

LITERATURE CITED

- (1) AKAMINE, E. K.
1953. CONTROL OF POSTHARVEST STORAGE DECAY OF FRUITS OF PAPAYAS (*CARICA PAPAYA* L.) WITH SPECIAL REFERENCE TO THE EFFECT OF HOT WATER. Amer. Soc. Hort. Sci. Proc. 61: 270-274.
- (2) BEATTIE, J. R., and DEMORANVILLE, I. E.
1962. FRESH FRUIT QUALITY STUDIES—1961. Cranberries 27 (5): 10-12.
- (3) BERGMAN, H. F.
1953. DISORDERS OF CRANBERRIES. Plant Diseases, The Yearbook of Agriculture, 789-796.
- (4) ——— and WILCOX, M. S.
1936. THE DISTRIBUTION, CAUSE AND RELATIVE IMPORTANCE OF CRANBERRY FRUIT ROTS IN MASSACHUSETTS IN 1932 AND 1933 AND THEIR CONTROL BY SPRAYING. Phytopathology 26: 656-664.
- (5) HATTON, T. T., and REEDER, W. F.
1964. HOT WATER AS A COMMERCIAL CONTROL OF MANGO ANTHRACNOSE. Proc. Caribbean Region, Amer. Soc. Hort. Sci. 8: 76-84.
- (6) HRUSCHKA, H. W.
1970. PHYSIOLOGICAL BREAKDOWN IN CRANBERRIES—INHIBITION BY INTERMITTENT WARMING DURING COLD STORAGE. U.S. Dept. Agr., Agr. Res. Serv. Plant Dis. Rptr. 54 (3): 219-222.
- (7) JOHNSON, H. B.
1968. HEAT AND OTHER TREATMENTS FOR CANTALOUPE AND PEPPERS. Yearbook of the United Fresh Fruit & Vegetable Assoc., pp. 51, 52, 54, and 56.
- (8) SHEAR, C. L., STEVENS, N. E., and BAIN, H. F.
1931. FUNGUS DISEASES OF THE CULTIVATED CRANBERRY. U.S. Dept. Agr. Tech. Bul. 258, 58 pp.
- (9) ——— STEVENS, N. E., WILCOX, R. B., and RUDOLPH, B. A.
1918. SPOILAGE OF CRANBERRIES AFTER HARVEST. U.S. Dept. Agr. Bul. 714, 20 pp.
- (10) SMITH, W. L., Jr., and REDIT, W. H.
1968. POSTHARVEST DECAY OF PEACHES AS AFFECTED BY HOT-WATER TREATMENTS, COOLING METHODS, AND SANITATION. U.S. Dept. Agr., Market. Res. Rpt. 807, 9 pp.
- (11) WRIGHT, R. C., DEMAREE, J. B., and WILCOX, M. S.
1937. SOME EFFECTS OF DIFFERENT STORAGE TEMPERATURES ON THE KEEPING OF CRANBERRIES. Amer. Soc. Hort. Sci. Proc. 34: 397-401.
- (12) ZUCKERMAN, B. M.
1960. DISEASE CONTROL EXPERIMENTS IN MASSACHUSETTS IN 1959. Cranberries 24 (10): 11-12.



